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# UNDERSTANDING AND IMPROVING DEPOT LEVEL REPARABLE PRICING FOR AIR FORCE SYSTEMS

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The Air Force has been under enormous pressure to reduce depot maintenance costs for weapon and support systems. To do this efficiently and effectively, requires a thorough knowledge of the cost of repairs to the component level. This knowledge enables the Air Force to: make sound judgments with respect to repair sourcing, determine the cost effectiveness of repair processes, justify continued expenditures for organic repair, and produce accurate comparative data. While the Air Force has made some progress in improving its capabilities in this area, it has yet to fully implement necessary procedural and system reforms. The Air Force?s ability to trace costs to individual systems and components is extremely limited due to the outmoded costing systems in use at its Air Logistics Centers. This paper investigates the difficulties in determining the actual costs of performing repairs on systems and components, and makes recommendations on methods, procedures, and systems to improve the accuracy of repair costing.

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## *Preface*

Recent experience with the Base Realignment and Closure Committee (BRAC) process led me to believe the Department of Defense is unable to accurately track costs associated with the repair and maintenance of individual weapon and support systems. As a result, I became interested in why such a conceptually simple activity is so difficult to perform in the real world. The answer I found lies in the shear size and complexity of the institutions and systems which support the DOD's maintenance processes and the ad hoc management and accounting systems used to control them. Scrutiny of these systems highlights many shortfalls. Principal among them is the need for the DOD to increase the efficiency of its business processes to facilitate decisions concerning the privatization and outsourcing of critical capabilities. This paper contains a review of some of the system's more significant problems and a discussion of some possible methods of correcting them.

I'd like to thank Mr. John Wallace of the Logistics Management Institute for his invaluable support in this effort. Mr. Wallace is quite familiar with the problems facing the DOD supply and maintenance system, and has provided many of the documents upon which this paper is based. I'd also like to thank Lieutenant Colonel Terry Pohlen for his efforts in directing my initial efforts to those with far more knowledge of the subject than me. And finally, I'd like to thank my advisor Lieutenant Colonel James Briggs for his support and guidance in the fulfillment of this graduation requirement.

## *Abstract*

The Air Force has been under enormous pressure to reduce depot maintenance costs for weapon and support systems. To do this efficiently and effectively, requires a thorough knowledge of the cost of repairs to the component level. This knowledge enables the Air Force to: make sound judgments with respect to repair sourcing, determine the cost effectiveness of repair processes, justify continued expenditures for organic repair, and produce accurate comparative data. While the Air Force has made some progress in improving its capabilities in this area, it has yet to fully implement necessary procedural and system reforms.

The Air Force's ability to trace costs to individual systems and components is extremely limited due to the outmoded costing systems in use at its Air Logistics Centers. This paper investigates the difficulties in determining the actual costs of performing repairs on systems and components, and makes recommendations on methods, procedures, and systems to improve the accuracy of repair costing.

# Chapter 1

# Introduction

Declining defense budgets and the need to maintain a force structure adequate to meet JCS taskings are forcing the Air Force to eliminate waste and inefficiency from its business practices. One business area that has been under particular scrutiny is the logistic and maintenance support for the Air Force's various weapon systems. Perceptions exist within and outside the Air Force that these costs are not well understood nor managed. The root causes of these perceptions are the complexity of the maintenance and support task and the fragmented and inadequate accounting and management systems used to control maintenance processes, inventories, and facilities. To address these perceptions and increase the efficiency and effectiveness of its maintenance system, the Air Force must make significant improvements in its maintenance policies and processes, and in its management and accounting systems. With these improvements, decision makers at all levels will gain a more thorough knowledge of the cost of maintenance activities and the consequences of management actions.

A thorough knowledge of maintenance costs would enable the Air Force to make sound judgments with respect to repair sourcing, the cost effectiveness of repair processes, and continued expenditures for organic repair. In addition, it would provide managers the ability to produce accurate data for many types of comparative studies.

While the Air Force has made some progress in improving its capabilities in this area, it has yet to fully implement necessary procedural and system reforms. In this paper, I discuss the impacts of inadequate systems and the difficulties in determining the actual costs of performing repairs. I also make recommendations on methods, procedures, and systems to improve the accuracy of repair costing.

## Depot Level Reparables

To limit the scope of this paper, I focus on one area of the depot maintenance business where cost issues appear to be significant, depot level reparables (DLRs). When a replaceable component malfunctions, it is replaced with a functioning spare from a local inventory. These replaceable components are referred to as DLRs.[1] The cost, or price, of a DLR is made up of two primary components, the depot repair cost and the Air Force Working Capital Fund (AFWCF) surcharge. A percentage breakdown of the AFWCF surcharge is shown below in proportion to the depot repair cost.

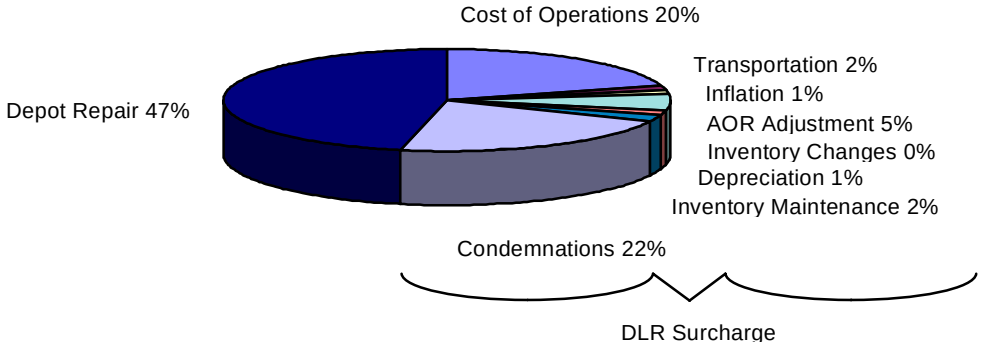


**Figure 1. FY 94 Operating Expense Breakdown for the AF DLR Stock Fund**

Erroneous policies and errors in the calculation of these cost components introduce possible errors in the DLR price charged to local units. In this paper, I focus on two

aspects of these costs where studies have indicated pricing errors are likely to occur. These aspects are the economic effects of forcing the consumer at the local unit to pay the DLR surcharge and the Air Force's limited ability to trace costs to individual DLRs at the depot level.

To understand the economic effects of forcing the local unit to pay the AFWCF surcharge, I begin with a discussion of the AFWCF maintenance business operations account. I then move to a discussion of the pricing errors introduced by the break-even policy of this fund. Following this, I address my second area of concern with a brief discussion of the Air Force's most recent failed attempt to update its outmoded management systems. I continue with a discussion of modern management and accounting techniques which, if implemented, would considerably improve the Air Force's ability to accurately cost repair of DLRs. Before concluding, I briefly review the Air Force's ongoing depot reform efforts.

## Notes

[1]William P. Rogerson, On the Use of Transfer Prices Within DOD: The Case of Repair and Maintenance of Depot-Level-Reparables by the Air Force (Logistics Management Institute, Mar 95), viii.

# Chapter 2

# Policy Induced Pricing Errors

## Air Force Working Capital Fund

The Air Force Working Capital Fund (AFWCF) is a financial account established under congressional guidelines through which users and suppliers of logistics and maintenance goods and services buy and sell their wares. The AFWCF is commonly known as a revolving fund and resembles a commercial business in that it uses the revenues it receives from selling goods and services to pay the fund's operating expenses and replenish its inventory. Congress established revolving funds to bring economic forces into the maintenance business. By establishing a buyer-seller relationship between consumers and suppliers of maintenance items, these funds attempt to increase the efficiency and effectiveness of all organizations involved. The guiding assumptions of the AFWCF are: since users must pay for the resources they consume, they should be motivated to be more efficient in their consumption; and, since suppliers must operate within the revenues they receive, they should be motivated to keep their operating expenses as low as possible. The AFWCF, along with revolving funds for the other service components, was established in December 1996 to replace the DOD-wide Defense

Business Operating Fund (DBOF). This change in the revolving fund structure should provide the Air Force more insight and control of its maintenance operations and costs.

The Defense Business Operations Fund was established in 1991 by consolidating nine stock and industrial funds managed by the Services and Defense Logistics Agency. After this consolidation, the DOD developed and implemented financial and operating policies designed to improve and standardize the operation and effectiveness of DBOF activities. To some extent, these policies resulted in increased visibility of the total cost of the support structure, improved efficiency and reduced costs to customers, development and application of unit cost measures, application of standard financial processes, direct involvement of the Service components in the development of DBOF policies, and selection of migratory financial automatic data processing systems.[1] However, DBOF suffered from several problems. Most notably were those regarding the Components' responsibility for managing and controlling the financial and functional aspects of their DBOF functions. The DOD recognized these issues and came to the conclusion that many could not be resolved without a major restructure of DBOF. This resulted in the dissolution of DBOF and the creation of the AFWCF and other component revolving funds. At present, the goals and policies of the AFWCF remain the same as that of DBOF.

## Pricing Policy

The creation of the AFWCF was intended to clearly establish the Air Forces' overall responsibility for managing and operating its working capital functions and achieving the financial goals established for each function. These functions include Depot Maintenance, Information Services, and Supply Management. Of primary concern in this paper is the

Depot Maintenance function of the AFWCF and the pricing policies, procedures, and systems employed by the Air Force to meet the financial goals of this function, particularly with respect to DLRs. It's in the pricing of DLRs that significant errors may occur. These errors lead to fundamental inaccuracies in Air Force assumptions and estimations regarding all aspects of repair sourcing, the determination of the cost effectiveness of repair processes, the justification of expenditures for organic repair, and the production of comparative data.

AFWCF's fundamental break-even precept, which leads to pricing errors, is that the revenues generated by the fund must cover the cost of the goods and services it supplies as well as the cost of managing the fund itself. To achieve economic efficiencies within the DLR process, the price of an item must be set equal to the cost of producing it.[2] If prices are set differently, they communicate the wrong information to purchasing organizations. This results in incorrect economic decisions on the repair and replacement of the item. Since the AFWCF charges prices above the actual cost of the item in order to cover a variety of operating and administrative expenses, it's likely that the Air Force is failing to achieve the economic efficiencies the AFWCF was established to generate.[3]

**Relevant Cost and Pricing Errors**

The relevant cost of an item supplied by AFWCF is the extra cost associated with the production of an additional item. This cost is known as the marginal cost. The current pricing structure which sets prices higher than the marginal cost, causes local military units to make poor economic decisions concerning the location of repair.[4] These units, which receive appropriations to fund repair and maintenance of DLRs, choose the location of the repair based upon cost. The supply system allows the unit to either repair the DLR at the

local level or turn the item over to the central logistics system for repair at a depot. Of course, the unit will make the repair location decision based upon which organization offers the lowest cost, thus maximizing the unit's maintenance dollars. It's through this mechanism that incorrect pricing leads to poor economic decisions.

The theory driving economic decisions within AFWCF is that as long as the central logistics' price for a repair is set equal to the actual cost, then the local military unit, when comparing this price against the local repair cost, would make the location of repair decision that is cost minimizing from the Air Force's perspective.[5]The problem lies in the price charged by the central logistics system. Since this price may be significantly higher than the actual, or marginal, cost of the repair, military units may choose to perform the repair locally; when in fact, this decision may be more costly to the Air Force as a whole. For example, assume the central supply system charges $1000 for a DLR. Also assume the depot repair cost for the item is $500. This implies the surcharge for this item is $500. These prices are roughly in-line with the FY94 DLR stock fund expense percentages shown in Figure 1. Now assume, the local unit can repair the item for $700 either at its own facilities or at a local contractor's facility. From the unit's perspective, the obvious economic choice is to repair the unit themselves. However, from the Air Force perspective, repairing the DLR at the local level would cost $1200 since the central supply system must fund its surcharge costs regardless of where the DLR is repaired. If the local unit had been charged the actual depot repair cost of the DLR, then it would have made the economically correct decision from the Air Force perspective.

A surcharge is added to the price of DLRs in order to defray the AFWCF's operating and inventory maintenance expenses. The surcharge, which is now known as the cost-

recovery-rate, covers the cost for condemnations (DLRs that cannot be repaired), the salaries and operating expenses for inventory management, and other operating expenses such as depreciation, transportation, inventory adjustments, and changes to the AFWCF's accumulated operating result (AOR). These expenses, which are shown in Figure 1, are spread arbitrarily to all DLRs. This spread results in two principal pricing errors.

The first pricing error concerns a failure to recognize that the supply system provides two different services to the local military unit.[6] These services are access to an inventory of functioning spares and the repair of the DLR. When a DLR is replaced, the local unit obtains a functioning spare from the supply system; while, repairs to the malfunctioning unit are made. Under the current system, all costs for repair, including inventory access, are allocated through the surcharge to each DLR. This policy allows the local unit to essentially gain access to the supply system inventories for free when it chooses to repair the DLR locally. Conversely, when it chooses to submit the DLR for repair by the supply system, it pays for both the repair and the entire cost of maintaining access to the inventories.[7] Based upon data from FY94, the price of the repair would be 28% lower if inventory access costs were not allocated to repair in this manner.[8]

The second pricing error occurs because of condemnations. The supply system adds an extra charge in the DLR surcharge to cover the cost of replacing DLRs which cannot be repaired. This extra charge is necessary because the price charged to the local unit for a replacement is the same for that of a repair; while, the actual cost of a replacement is generally much higher than that of a repair.[9] Again based upon FY94 data, the price of the DLR would be 23% lower if this additional charge were not allocated to repair in this

manner.[10] Taken together, DLR prices would be 51% lower if these two charges were excluded.

Resolving these pricing errors requires changes to the reimbursement policies of the AFWCF. A Logistics Management Institute study of this issue recommended that "central logistics costs other than transportation costs should not be allocated to repair/replacement for purposes of creating prices for repair/replacement."[11]Instead, it recommended these costs be charged as annual fees to users of the supply system. In addition, it recommended that "...the excess of condemnation costs over revenues...should be aggregated in a single [cost] pool and [also] charged as an annual fee to users..."[12] These policy changes would significantly lower the DLR cost to the local unit, thus fostering better economic decisions from an Air Force perspective.

The pricing errors discussed above result from AFWCF reimbursement policies. Another pricing error occurs as a result of the poor management and accounting systems employed at Air Logistics Centers. It is discussed in the following chapter.

**Notes**

[1]John J. Hamre, Department of Defense Comptroller: Memorandum for DBOF Corporate Board Members, Special Advisor, and Observers, Working Capital Funds for Defense Support Organizations, 11 Dec 96, 1.

[2]William P. Rogerson, On the Use of Transfer Prices Within DOD: The Case of Repair and Maintenance of Depot-Level-Reparables by the Air Force (Logistics Management Institute, Mar 95), viii.

[3]Ibid., viii.

[4]Ibid.

[5]Ibid., ix.

[6]Ibid., x.

[7]Ibid.

[8]Ibid.

[9]Ibid., 5-1.

[10]Ibid., x.

[11]Ibid., 4-1.

## Notes

[12]Ibid., 5-2.

# Chapter 3

# System Induced Pricing Errors

The Air Force's inability to accurately track and allocate the cost of repairing individual DLRs at its Air Logistics Centers leads to DLR pricing errors. Currently, the supply system charges the same price to repair a DLR regardless of the difficulty of the repair or the associated depot overhead costs. One result of this is that local units are deciding on the basis of cost to make easier repairs even if the repair could actually be made more cheaply at the depot. The cumulative effect of these local decisions is to drive up the average cost of repairs at the depot. This in turn forces the depot to raise its prices to cover the higher average cost. These higher prices are, of course, passed back to the local units which further exacerbates the problem.[1] The resolution of this issue lies in the overhaul of the management and accounting systems in use at the Air Logistics Centers.

## Depot Accounting and Management Systems

The purpose of the management and accounting systems used in the Air Force supply system is to provide the necessary information to assess the financial condition of the system, set prices and pricing policy, enable future planning, and allow managers to run the Air Force's depots as efficiently and cost effectively as possible. Specifically, this information should allow managers to determine whether the depot is incurring profits or

losses from current operations and whether opportunities exist to reduce costs by modifying products, policies, procedures, or processes.

The Air Logistics Center's management and accounting functions are provided by a large suite of legacy systems. Some of these systems, such as the Industrial Fund General Ledger System, are dedicated to financial functions. Others, such as the Jog Order Production Master System, are only partially financial.[2] In all, there are approximately fourteen legacy systems which provide significant accounting functions for the supply system. Most are mainframe-based 1970s technology systems which do not interface with each other. Consequently, they do not operate as a single entry system and require significant manual intervention for data transfer. Of significant import is that this suite of systems has never been validated as an accounting system and has not been graded against Defense Finance and Accounting System functional requirements.[3]

## Failed System Enhancements

The Air Force recognized the need to upgrade and enhance these systems and began to do so in 1986. This effort, which focused on the development of the Depot Maintenance Management Information System (DMMIS), was the result of a Manufacturing Resource Planning (MRP II) demonstration project conducted at Ogden Air Logistics Center. MRP II was a closed-loop planning and control system designed to coordinate capacity planning, production scheduling, shop floor control, job control, and material ordering and control.[4] The Air Force attempted to significantly upgrade the capabilities of the MRP II system through extensive modifications and additions to the original commercial-off-the-shelf (COTS) software. DMMIS was intended to link

functional areas within depots, including receiving,, inspection, inventory control, quality control, planning, scheduling, routing, data collection, data processing, finance, and forecasting.[5] By 1995, DMMIS was still not operational, significant problems continued to surface, and substantial cost growth had become a serious concern. As a result, the Air Force canceled the program and was left with its original suite of legacy systems.

Lessons learned from DMMIS's failure indicate that the Air Force's legacy systems cannot be replaced in a wholesale manner. The shear complexity of the supply system demands that the Air Force take a much more evolutionary approach to the replacement of its legacy systems and the integration of modern management and accounting systems. An evolutionary approach is necessary because of the significant changes required in practically every depot maintenance processes to take advantage of modern production methods and techniques. With these systems, the Air Force should gain the ability to accurately track all management and accounting aspects of the supply system. These changes will enable the Air Force to resolve the DLR pricing problems discussed earlier.

## Modern Accounting and Management Systems

Modern production and control systems and techniques enable large industrial organizations to produce their goods and services in the most cost effective manner. These systems and techniques are applicable to the Air Force's supply and maintenance business. Two techniques, just-in-time (JIT) manufacturing and activity-based-costing (ABC), are especially applicable as the Air Force implements its Depot Repair Enhancement Program (DREP) and Lean Logistics (LL) program.

## Just-In-Time Manufacturing

In the broadest sense, JIT is a philosophy that focuses on performing activities *as they are needed* by other internal segments of an organization. JIT principles can be applied to many areas of the manufacturing process including purchasing, production, distribution, and retailing. Even administrative functions such as payroll and accounts payable are amenable to JIT methods.[6] In actual practice, JIT is most applicable to repetitive processes like many of those found in Air Logistics Centers.

**Inventory Reduction and the Demand Pull System.** JIT production methods focus on the provision of materials and components when and where they are needed in the manufacturing or repair process at the moment the need arises.[7] Each stage of these processes can be viewed as a link in a manufacturing chain. Raw materials, attached to the end of this chain, are pulled through successive stages of the process by the next link in the chain, just as that stage becomes ready to begin its work on the material. This pulling of parts from one stage by the next is the genesis of JIT's description as a "demand pull" system. In an integrated environment, just-in-time delivery applies throughout the production process from outside suppliers to finished goods distribution centers.

The primary motivations behind implementation of a demand pull system are a significant reduction in all types of inventories, the exposure and correction of production problems, increased manufacturing flexibility, significant reductions in manufacturing costs, and an enhanced competitive position. Material, work-in-process (WIP), and finished goods inventories are reduced because no manufacturing occurs unless required to meet the demand generated by a succeeding operation. As applied to DLR induction into the depot repair process, JIT implementation argues that no DLR should be repaired

unless required to meet the needs of local units. This is a basic characteristic of the Depot Repair Enhancement Program where only those DLRs submitted by local units are scheduled for repair. This approach results in a significant reduction in inventories and elimination of inefficient and wasteful practices such as repairing stockpiled DLRs for which there's no demand; a common practice at Air Force depots in the past. Carrying inventories, which in traditional manufacturing environments is viewed as necessary for a variety of reasons, is viewed as waste in the JIT environment. Inventories tie up resources such as cash, space, and labor while increasing administrative burdens.

Elimination of inventories is not without risk and reward. JIT techniques impose a high degree of exposure to uncertainty. JIT, by definition, aims to decrease slack resources and thereby foster interdependency among repair processes and end users. Consequently, the Air Force must assume some risk of work stoppage due to problems in the conduct of repairs or with material deliveries. At the same time, however, JIT exposes problems which may have been hidden by excessive inventories. Such problems usually involve machine failures, defective materials or subassemblies, or unavailable materials. JIT reduces inventories, exposes problems, and then focuses on resolving them. It's through this mechanism that JIT plays a major role in increasing efficiency and productivity and enhancing quality.

**Total Quality Control and Information Provision**. Effective implementation of JIT methods necessitates a strong focus on quality control and information provision at all organizational levels. The reasons are simple and interrelated. Poor quality cannot be tolerated in an environment that operates with minimal buffer and safety inventories; because, any defect in raw materials, subassemblies, or processes can seriously impact

production.[8] In addition, the lack of these inventories, coupled with the continuous push to decrease all slack resources, increases the need for production and performance information critical to the coordination of the manufacturing process.[9]

The reduction of slack resources increases uncertainty and makes the coordination of activities more critical and difficult. Strategic control systems designed to implement JIT must therefore provide increased information regarding materials, work-in-process, inventories, and other factors critical to this coordination.[10] Information provision reinforces the focus on continuous inventory reductions and motivates efforts on objectives critical to JIT techniques.

**Manufacturing Cells and Process Flow.** The implementation of JIT techniques requires a holistic approach to the design of production and repair processes.[11] The goal is to ensure a balanced work flow with a minimum of work-in-process inventory. Consequently, depot process designers must focus on the type and placement of production and repair equipment. Effective implementation often involves restructuring plant layout into production cells, streamlining material handling requirements, and reducing setup times. While recognizing this is a difficult and costly undertaking in the Air Force's depots, opportunities may exist as workloads are transferred from closing depots to those remaining open. Also, opportunities may exist as workloads are phased out when the Air Force retires existing systems and new systems are brought on-line.

Other objectives which are vital to successfully implementing JIT are the reduction of production lead times, setup times, and lot sizes. Reduced lead times will allow the depots to quickly respond to changes in demand and to reduce changes to supplier orders. This will significantly improve their ability to respond to changes in demand and other factors

affecting the repair process. To be able to achieve these advantages however, the production lot size must be reduced as far as possible, ideally to a single piece. This of course requires that production operations, such as machine setup time, be conducted as efficiently and rapidly as possible. In fact, it's only through the reduction in setup times that reduced lot sizes become economically feasible.[12]

Lot size reduction is a critical step in achieving plus or minus zero performance to schedule. Zero performance to schedule means the depot produces only the quantity of DLRs needed, no more, no less. By reducing lot size, it becomes feasible for the depot to fill orders through production instead of from inventory.

**Multi-Skilled Labor and Decentralization of Services**. Labor usage is fundamentally different between traditional and JIT manufacturing environments. In the traditional environment, labor tends to be specialized. Workers are trained to perform a single operation or operate a single machine and are not encouraged to become multi-skilled. Using labor in this manner is considered a waste of resources in a JIT environment. Here a primary goal is the flexible use of resources. JIT workers are trained and expected to perform multiple tasks. They would, for instance, be trained to operate and maintain multiple pieces of equipment. Idle time is used by workers to service equipment, perform material handling functions, participate in quality focus groups, or perform other value-added activities.

A tenet of the JIT philosophy is locating materials and inventory where they're needed to increase efficiency. This tenet applies equally well to depot support services. Centralized support services must be downsized and relocated to work directly with the

areas supported. This ensures a rapid and dedicated response to repair needs and the minimization of any impacts on the repair process.

**Schedule Stabilization and Vendor Support.** In order to achieve efficient processes, schedules must be level. Ultimately, this means that changes in the schedule are able to be "pulled" through the repair processes in the normal course of repairing DLRs. Pulling these changes through the system allows repairs to be performed without significant perturbation of the process or waste of resources. This is a viable approach in JIT systems because of short repair cycles and small lot sizes.

Typical JIT environments use a master schedule to determine the final assembly or repair schedule. The final schedule is used, in turn, to schedule material deliveries and repair of sub-assemblies based on when these items will be needed. Changes to procedures or production are worked into the master and final schedules in the same manner as routine orders.

It is common in JIT systems to observe unused machines. This unused capacity can be viewed as the cost of eliminating inventories as a buffer in the system. In traditional systems, safety stock and early deliveries are used as a hedge against shortfalls in production resulting from such things as poor quality, machine failures, and unanticipated bottlenecks. Under JIT, excess labor and machines provide that hedge in lieu of inventory.[13] In addition, these unused machines would support the Air Force's unique requirements for organic wartime maintenance surge capability.

While low inventory levels are a primary JIT goal, they are difficult to achieve in practice due to factors beyond the direct control of the depot. Ensuring timely receipt of spare parts is a common example of this difficulty. One approach used to resolve this issue

is the development of special relationships with suppliers. These relationships are necessary to ensure parts arrive at the right time and location and in the right quantity. A common argument against frequent deliveries however, is the cost of shipping. It's readily determined though, that these costs are generally insignificant compared with the cost of maintaining unnecessary inventories.[14]

**Activity Based Costing in JIT Manufacturing**

Installation of a JIT production system has many implications for the cost accounting system. Some of the more important include significantly enhanced cost traceability, more accurate product costing, cost driver and allocation base changes, increased cost control, and reduced production costs.[15]

Overhead costs, as seen in the surcharge on DLRs, are extremely significant in the Air Force's supply system. As a result, they have a significant negative impact on economic efficiency. JIT systems will allow the depot to lower these costs by increasing their traceability, converting them to direct costs, and constantly striving to reduce non-value added processes. Unfortunately, the depots' cost accounting systems have not been modified to reflect the changing conditions under which materials are purchased and used. As a result, these systems give too little attention to internal cost controls.[16] Traditional cost accounting procedures focus on labor based overhead cost absorption rather than overhead cost reduction. Because of this, suppliers often produce in advance of customer demand creating unnecessary material and product inventories. In addition, traditional systems emphasize the use of standard costing and variance analysis to direct management's attention to areas where actual conditions differ from expectations. These practices are completely inadequate and inappropriate in the JIT environment.

**Overhead Cost Traceability.** One of the most significant implications of movement to a JIT production philosophy is the increased traceability of overhead costs. Cellular manufacturing, multi-skilled labor, and decentralized service activities are the primary features of JIT responsible for this increased traceability.[17] In the supply system environment, a typical depot incurs many material handling and warehouse costs, which it classifies as indirect. Conversely, in the JIT environment, material handling facilities are often dedicated to a single production line and warehousing is eliminated. As a result, material handling can be readily traced to individual products and classified as a direct cost.

The use of dedicated repair lines or cells also enhances cost traceability. Equipment which may be used to repair multiple DLRs can be consolidated to form cells allowing costs to be traced directly to individual DLRs. Multi-skilled workers add to this effect.[18] They not only repair DLRs, they may also perform material handling, setup, and maintenance at the cellular level. As a result of consolidating these and other support activities, this indirect labor becomes directly traceable to the DLR.

The use of automated manufacturing systems would further enhance the Air Force's ability to trace costs. Computer control allows the accurate measurement of, and real time access to, production costs for individual DLRs. Using this information, management would be better able to understand and control overhead costs.

**Product-Costing Accuracy.** One result of the conversion of indirect costs to direct costs is improved product costing accuracy. Another is the ability to use cost drivers to allocate the remaining overhead costs which aren't perfectly correlated with consumption.[19] These two effects are extremely important in the development of a cost

accounting system which takes advantage of JIT and provides motivation for further improvement.

The goal of activity-based costing (ABC) systems is to relate a production activity to the need for it, and the resources consumed by it.[20] Because of this, activity-based cost systems work well with the increased costing accuracy of the JIT environment. An ABC system requires the identification of four activity categories; unit, batch, product, and facility. Unit-level activities are those performed each time the depot produces a unit. Batch-level activities are those performed each time the depot produces a batch of DLRs. Costs of batch-level activities vary with the number of batches but are fixed with respect to the number of DLRs produced. Product-level activities are those performed as needed to support the many DLRs produced in the depot. Finally, facility-level activities are those that sustain the depot's general repair processes.

Implementation of an ABC system in an ideal JIT environment would lead to an important simplification of cost allocation methods. Since the ideal batch size in a JIT system is one unit, implementing an ABC system would cause all batch costs to become unit-level costs. Thus, only three ABC categories would be applicable. In even non-ideal JIT environments, many batch-level activities are eliminated by their conversion to direct costs.

Another implication of using an ABC system in a JIT environment is the possible creation of a new cell-level activity category.[21] Cell-level activities would be those that sustain the cell process, such as supervision. They would not vary with the number of units produced nor with product-level activities. And, unlike facility-level activities, they would be traceable to individual DLRs.

**Direct Labor Cost Reduction.** JIT systems have a significant impact on direct labor costs (DLC) due to process automation and development of a multi-skilled work force. Process automation decreases DLC by reducing or eliminating labor intensive activities. Multi-skilled workers stabilize DLC as production fluctuates because production labor is used for other tasks, such as preventive maintenance, during slack production periods. These two effects result in direct labor decreasing as a percentage of total repair costs and changing from a variable cost to a fixed cost.

**Simplification of Inventory Valuation.** In the JIT environment, inventory is reduced to insignificant levels. Consequently, determining product cost for inventory valuation is unnecessary. In the traditional manufacturing environment, the accounting department expends a significant amount of effort valuing inventory. Implementation of JIT frees these resources.[22] They are then able to focus on implementation of strategic accounting systems which provide management the information it needs to make accurate and informed strategic business decisions.

**Job-Order and Process Costing Implications.** JIT techniques lead to simplification in job-order costing. The depot can simplify both production and costing by separating high volume repairs from low volume repairs. They can accomplish this by setting up production cells for the high volume repairs and grouping the necessary equipment to perform low volume repairs of different DLRs which require similar repair sequences. These changes would allow the depot to accumulate product costs at the cellular level instead of by job order. Further, the unit sized batch levels, short lead times, and reductions in WIP and finished goods inventories that are the hallmark of JIT, make job

orders for each job unnecessary. As a result, the job-order environment takes on the nature of a process costing system.

**Summary**

JIT production systems supported by properly integrated accounting and management control systems are the cornerstone of world class manufacturing. Traditional manufacturing methods are unable to meet the demands of low cost, flexible production required in today's rapidly changing environment. While implementing JIT without concurrent update of control systems can be effective in reducing some repair costs, this piecemeal approach fails to take advantage of the many cost and production benefits offered by integration.

Successfully implementing JIT techniques demands an Air Force commitment to quality, change, and the elimination of waste. Without it, the Air Force cannot succeed.[23] The changes required in the manufacturing environment are simply too fundamental and the barriers too high to be overcome without support at all levels. While JIT techniques and modern accounting systems are conceptually simple, implementation will be a significant challenge in the depot environment.

**Notes**

[1]William P. Rogerson, On the Use of Transfer Prices Within DOD: The Case of Repair and Maintenance of Depot-Level-Reparables by the Air Force (Logistics Management Institute, Mar 95), xi.

[2]David V. Glass, et. al., Economic Analysis of the Depot Maintenance Accounting Systems: Volume 1: Results and Analysis (Logistics Management Institute, Apr 96), 5-1.

[3]Ibid., 5-2.

[4]Ibid., 5-3.

[5]Ibid., 5-4.

[6]George Foster and Charles T. Horngren, "Cost Accounting and Cost Management in a JIT Environment", Journal of Cost Management, Winter, 1988

## Notes

[7]Shirley J. Daniel, "Management Control Systems for JIT: An Empirical Comparison of Japan and the US", Journal of International Business Studies 1991, v22n4 Fourth Quarter.

[8]Nicholas J. Aquilano, Richard B. Chase, and Mark M. Davis, *Fundamentals of Operations Management*, Second Edition, 1995.

[9]Daniel.

[10]Ibid.

[11]Ibid.

[12]Ibid.

[13]Aquilano.

[14]Thomas E. Phillips and John R. Ledgerwood, "Running with the Pack, JIT & Automation for Small Manufacturers", National Public Accountant 1994, v39n6, June.

[15]George Foster and Charles T. Horngren, "Cost Accounting and Cost Management in a JIT Environment", Journal of Cost Management, Winter, 1988.

[16]Margaret L. Gagne and Richard Discenzq, "Accurate Product Costing in a JIT Environment", International Journal of Purchasing Management, Fall 1992.

[17]Don R. Hansen and Maryanne M. Mowen, *Management Accounting*, Third Edition, 1994.

[18]Hansen.

[19]Ibid.

[20]Gagne.

[21]Hansen.

[22]William O. Stratton, "ABC: An All-Purpose Solution for Financial Reporting", Management Accounting, May 1993.

[23]M. C. Bonney, "Trends in Inventory Management", International Journal of Production Economics 35 (1994).

# Chapter 4

# Depot Repair Reform Efforts

The Air Force has undertaken several initiatives to address management and accounting shortfalls in its depot maintenance business. A primary effort is the implementation of the Lean Logistics program mentioned earlier. Essentially, this program is designed to ensure that the Air Force provides the right parts to the right place when needed using as few resources as possible. The Air Force is doing this by focusing on meeting customer mission requirements, applying modern business practices, and making system-wide changes through process reengineering. The Lean Logistics program has begun the process of increasing the responsiveness and efficiency of the Air Force's depots. However, real improvements in this area require such significant changes to entrenched policies, systems, and bureaucracies that a highly focused initiative is required. This initiative is the Depot Repair Enhancement Program.

The Depot Repair Enhancement Program (DREP) is a new way of doing business in the depots. DREP places materiel managers (MMs) and "fixers" in charge of the repair process by increasing their authority and responsibility and visibility of world-wide assets. Materiel managers are the key to efficient day-to-day operations of customer-driven repair activities. Their responsibilities include: monitoring field, serviceable inventory, and pipeline requirements; knowing current inventory status and location; setting parameters

to distribute serviceable inventory in the correct priority; assisting field units with item-related issues; assisting the fixer and shop service center with limitations to repair beyond their capabilities; and providing "big picture" item assessment. In addition, the Air Force has begun the arduous task of developing and implementing the new processes and systems required for DREP while retraining personnel at all levels of the depot maintenance organization. In addition to DREP, the Air Force is implementing the Contract Repair Enhancement Program (CREP) to ensure that contract repair mirrors Lean Logistics repair. Pacer Lean is the Air Force's initial implementation of all DREP processes for DLRs, tools that support the processes, and training. Ten organic shops and 3-5 contracts per Air Logistics Center will participate in the Pacer Lean program. It is in the implementation of these programs that the Air Force has the opportunity to pursue the integration of JIT and ABC systems and techniques.

# Chapter 5

# Conclusion

The Air Force is under enormous pressure to eliminate waste and inefficiency in the maintenance of its weapon and support systems. Unfortunately, the complexity of the problem and the fragmented and inadequate accounting and management systems employed to control the maintenance process have seriously hampered the Air Force's efforts. Although attempts such as DMMIS have been made to upgrade critically important accounting and management systems, these efforts have been largely unsuccessful. The maintenance system is simply to large and complex with to many entrenched interests to be amenable to wholesale rework. Updating this system requires a holistic approach involving ADP upgrades, process and facility modifications, significant retraining, and focused leadership.

AFWCF pricing policies must be reconsidered in light of the economic impact of current pricing policies. The allocation of cost components of the AFWCF surcharge to DLR prices causes local units to make poor economic decisions from an Air Force perspective. These decisions drive up the Air Force's maintenance costs causing the inefficient use of limited resources. The Air Force must review these cost allocation policies for negative impacts and consider their reallocation.

Air Logistic Center processes must be modified to make use of modern manufacturing and accounting methods. These methods, such as just-in-time manufacturing and activity-based costing, provide managers with the tools and information necessary to make informed business decisions. In addition, they provide the necessary information to allow these managers to set appropriate prices for the goods they produce. This allows users at local units to make repair decisions based upon valid pricing data which leads to proper economic decisions from an Air Force perspective. This, in turn, leads to greater understanding and control of the AFWCF and significant enhancement of the Air Force's ability to make sound judgments with respect to repair sourcing, the cost effectiveness of repair processes, and continued expenditures for organic repair.

The costs of maintaining the Air Force's weapon and support systems continue to climb. Without improvements in the AFWCF's pricing policies and depot management and accounting systems, these costs will adversely impact the Air Force's ability to sustain the force structure required to meet its war fighting obligations. Consequently, the Air Force must focus leadership and resources on the upgrade of these systems. To do less imperils the world's most respected Air and Space force.

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